Adaptation of the energy sector to climate variability and change using seasonal/mid-term climate forecasts

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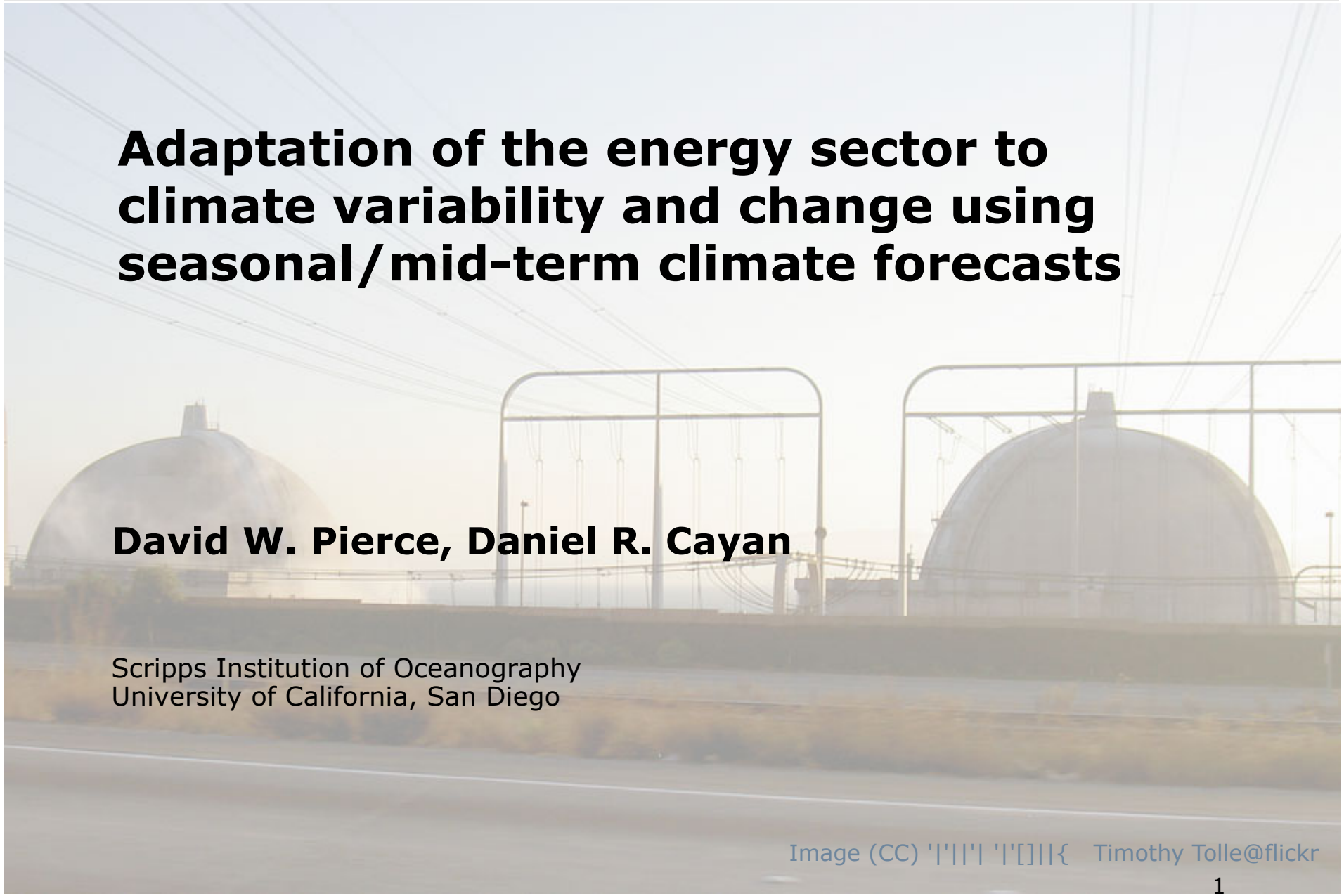
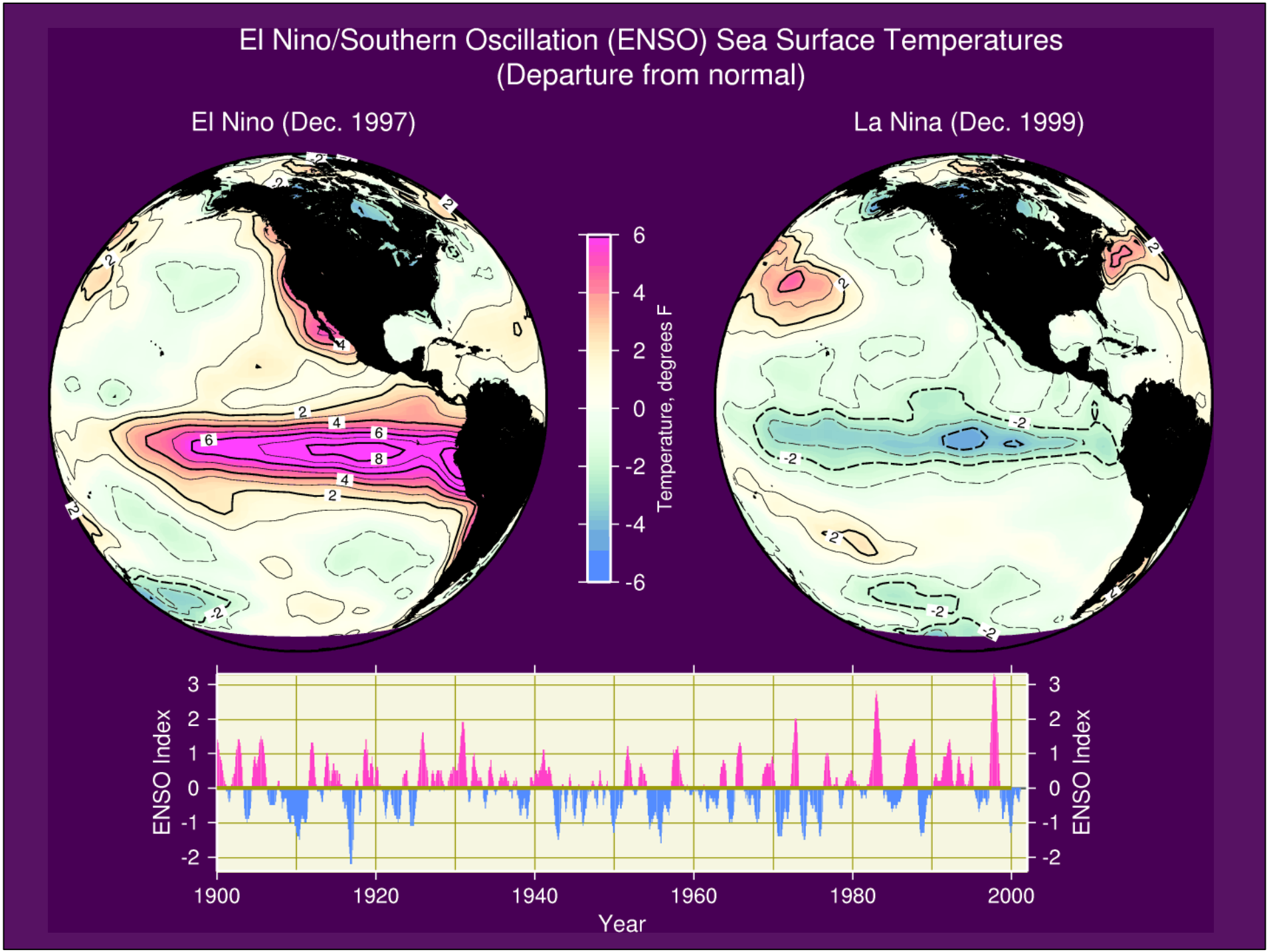
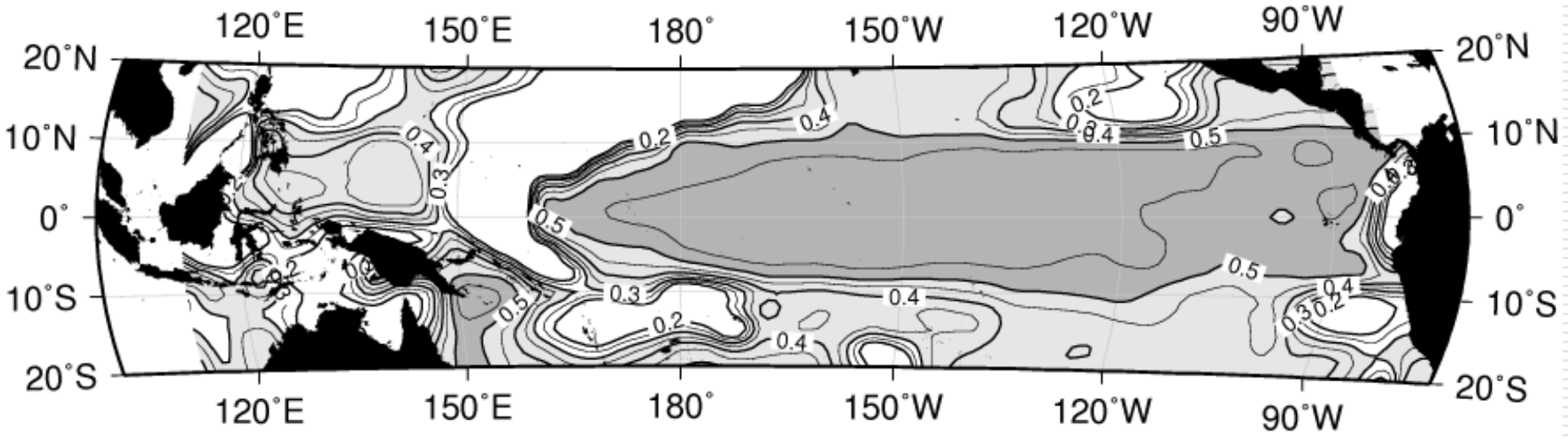


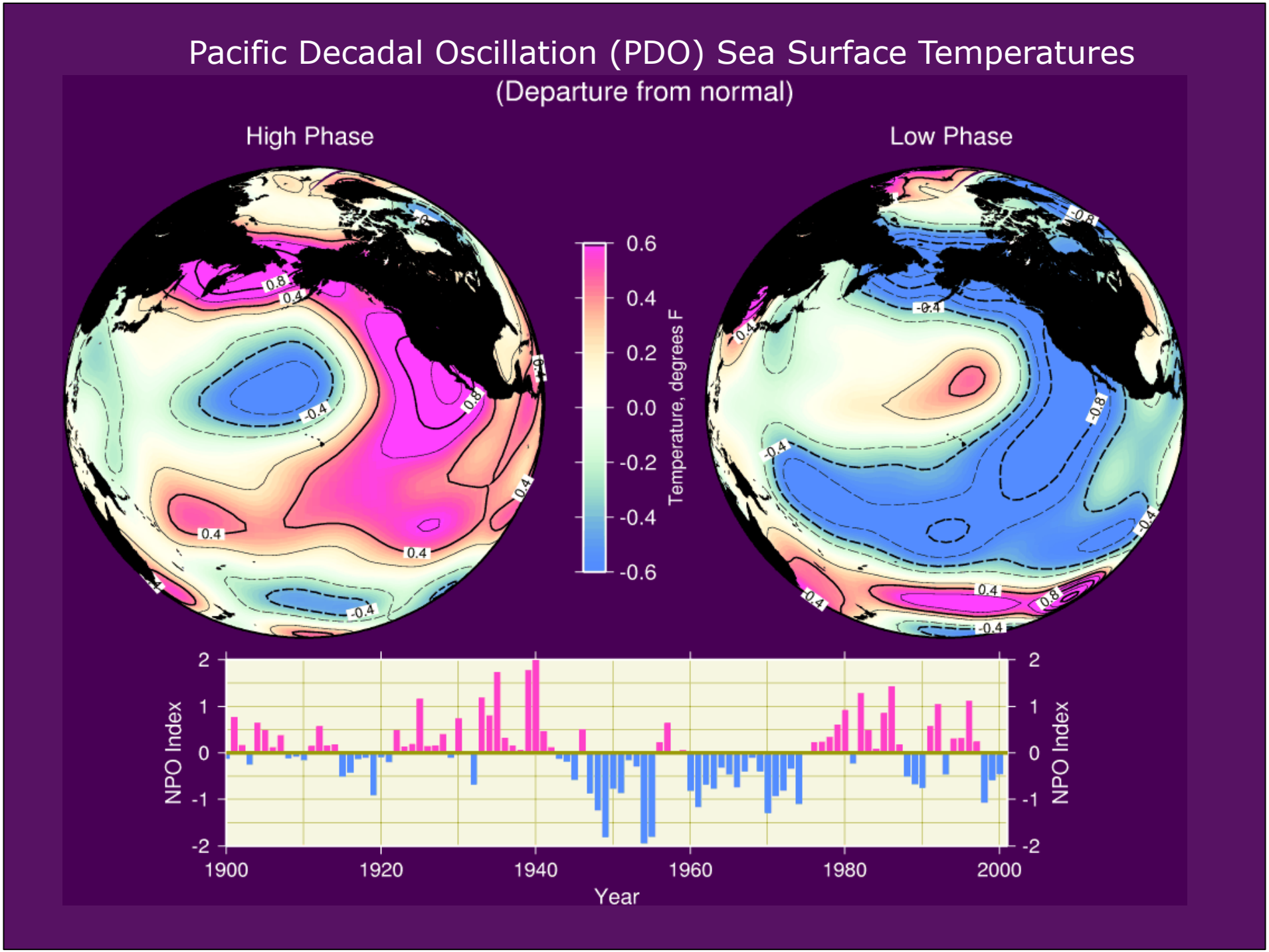

El Nino/Southern Oscillation (ENSO) Sea Surface Temperatures
(Departure from normal)
El Nino (Dec. 1997)
La Nina (Dec. 1999)
Temperature, degrees F
6
4
2
0
-2
-4
-6
ENSO Index
3
2
1
0
-1
-2
1900
1920
1940
1960
1980
2000
Year

El Nino/La Nina forecast

1-year lead time

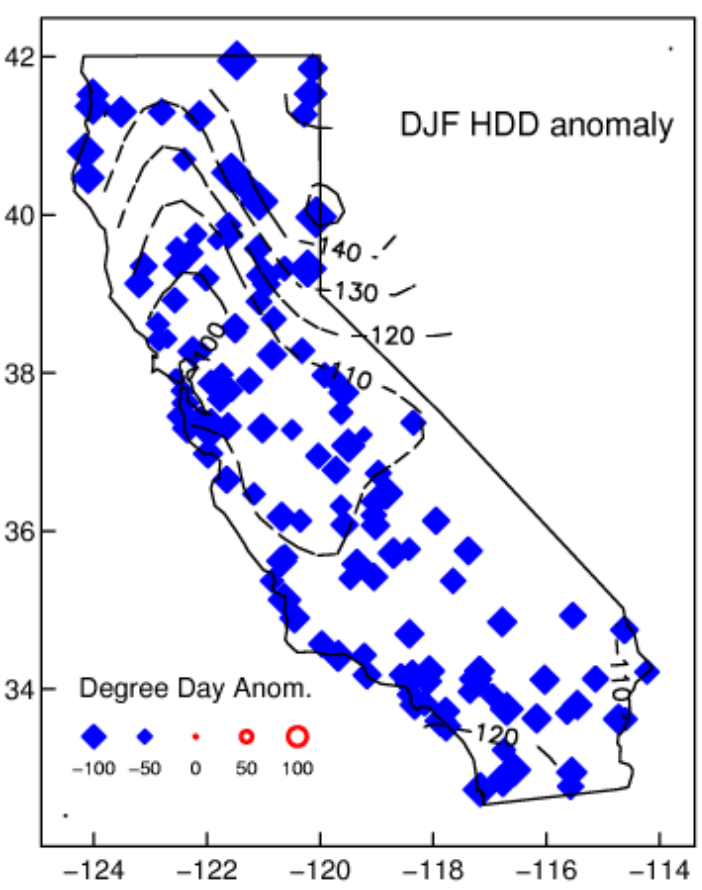


Correlation, forecast to observed SST anomalies, over verification period (1965-93)

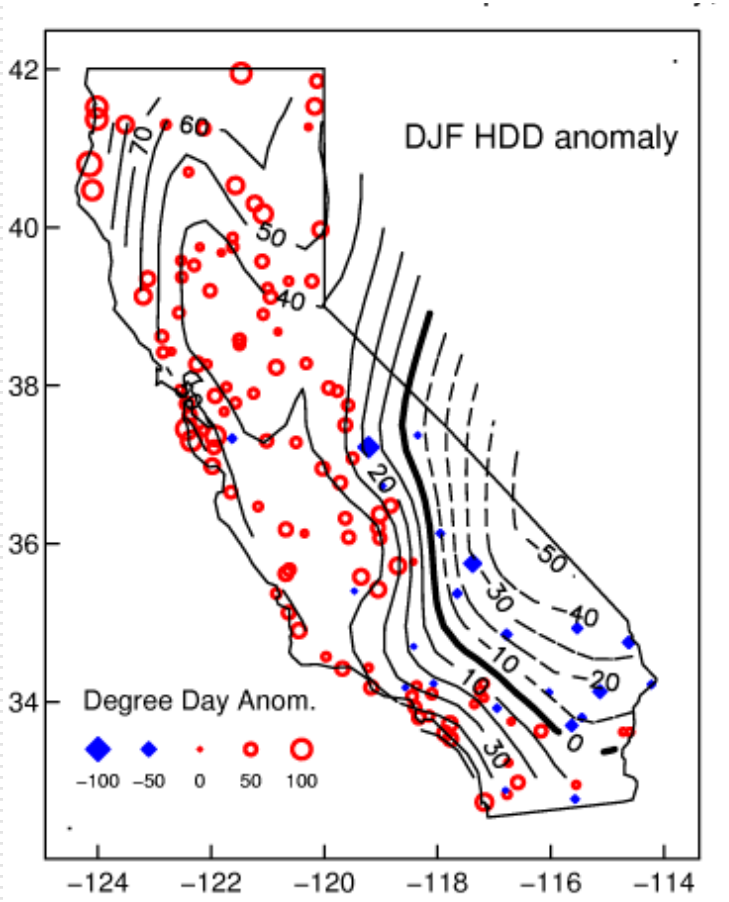

Pacific Decadal Oscillation (PDO) Sea Surface Temperatures
(Departure from normal)
High Phase
Low Phase
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Temperature, degrees F
NPO Index
2
1
0
-1
-2
1900
1920
1940
1960
1980
2000
Year

PDO and heating degree days (HDD)

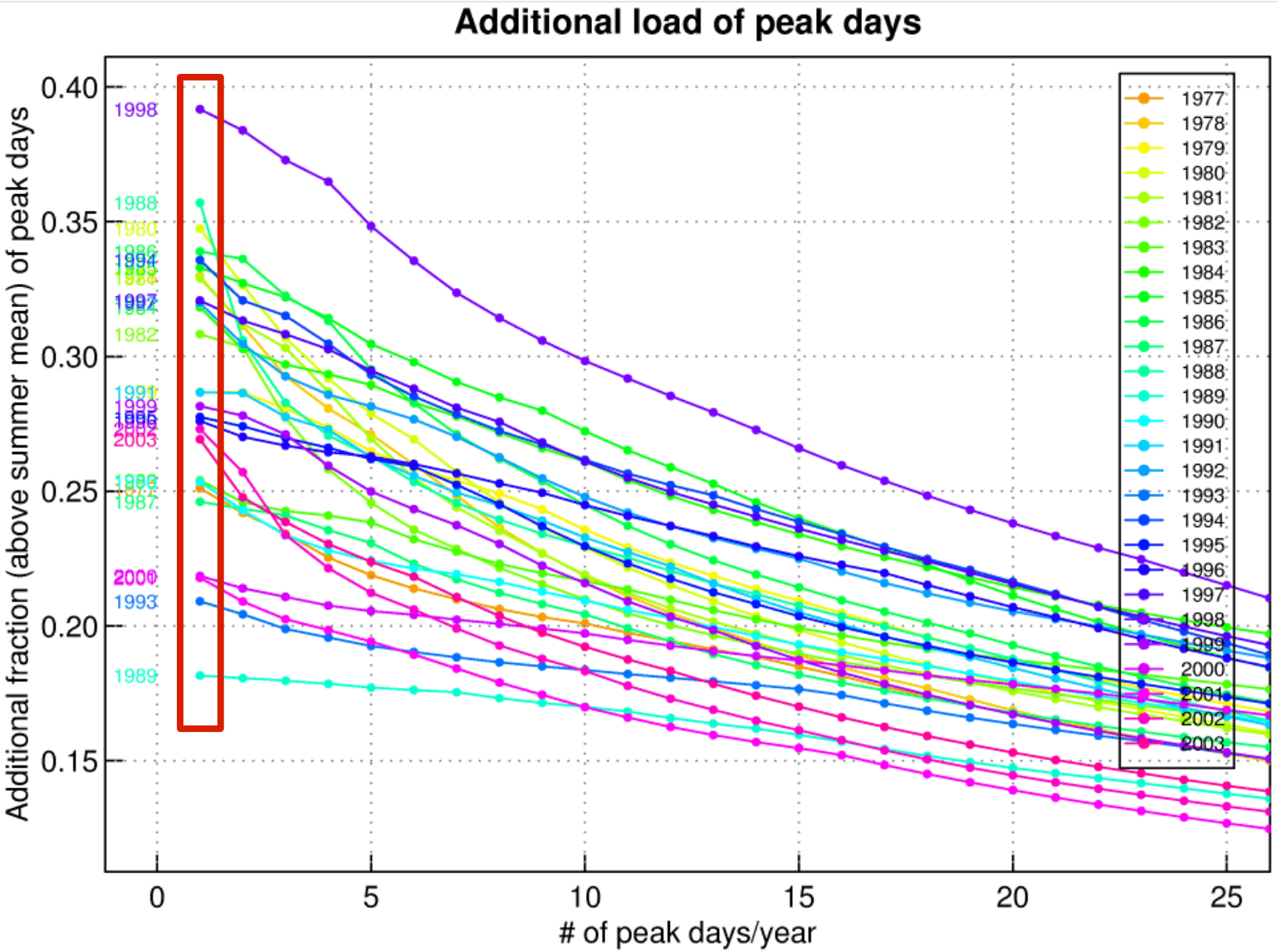
Positive PDO

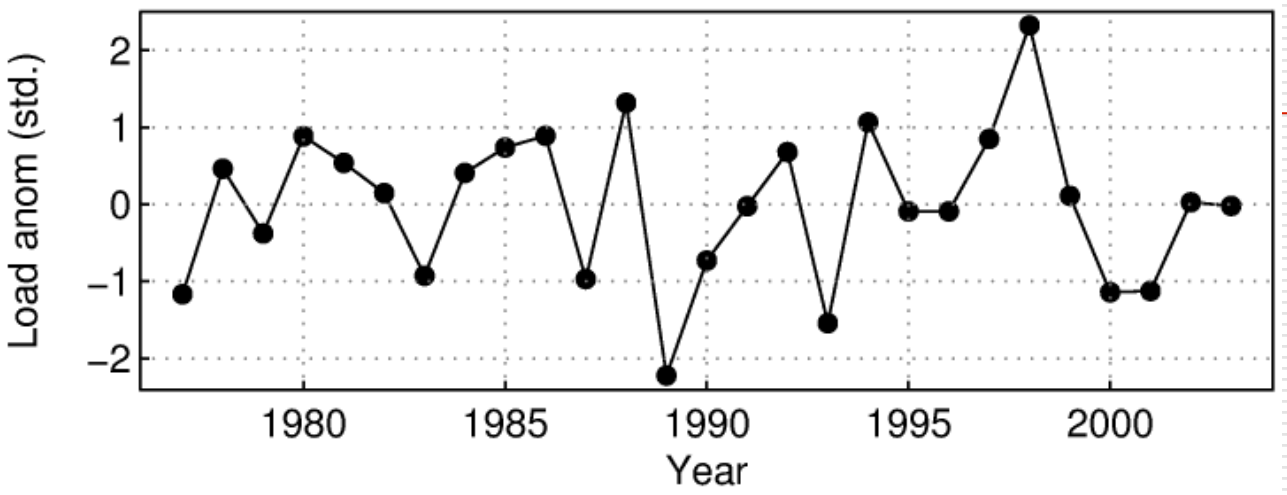


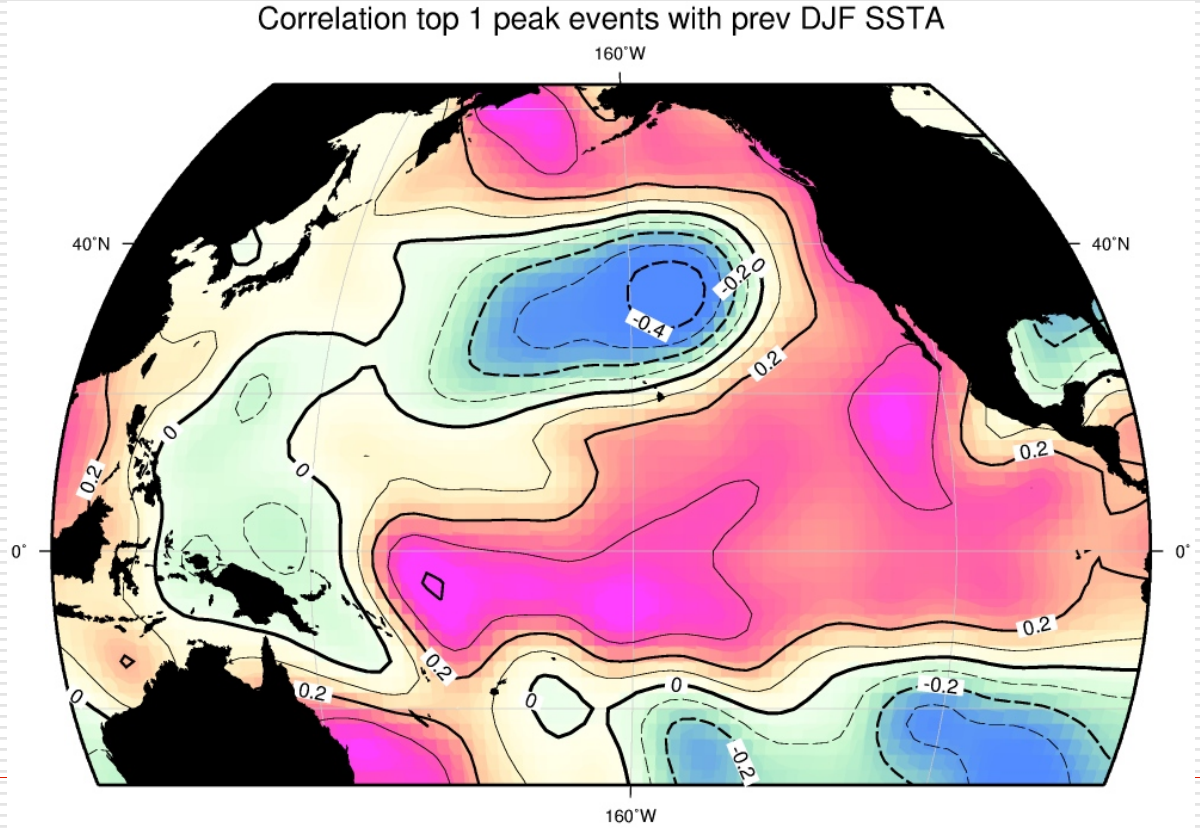
Negative PDO



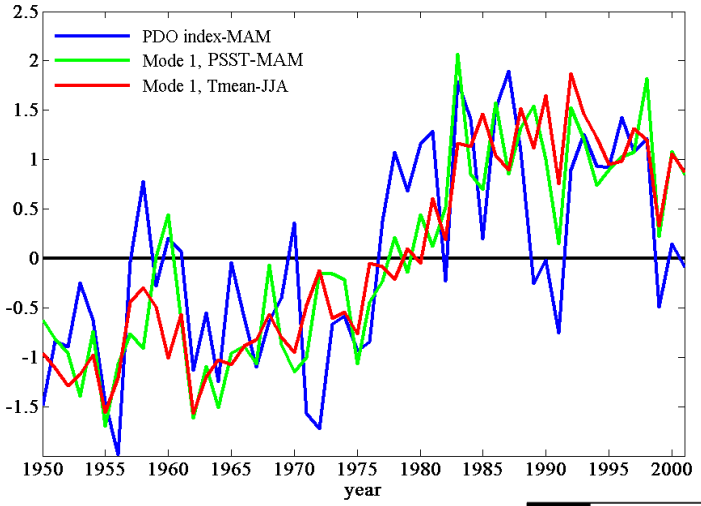
Peak electrical load



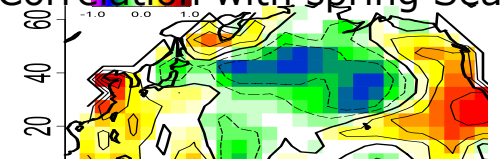

Load anom (std.)
2
1
0
−1
−2
1980
1985
1990
1995
2000
Year


Correlation top 1 peak events with prev DJF SSTA
160°W
40°N
0°
160°W
-0.4
-0.2
0
0.2

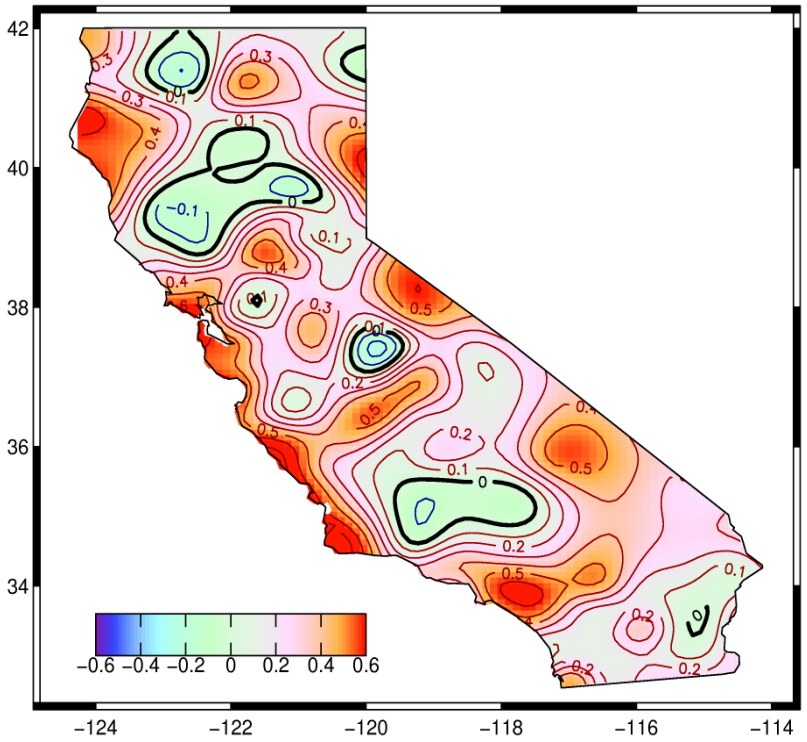
Spring PDO predicting summertime temperatures



Correlation with spring Sea Surface Temp.



Correlation with summer (JJA) Tavg



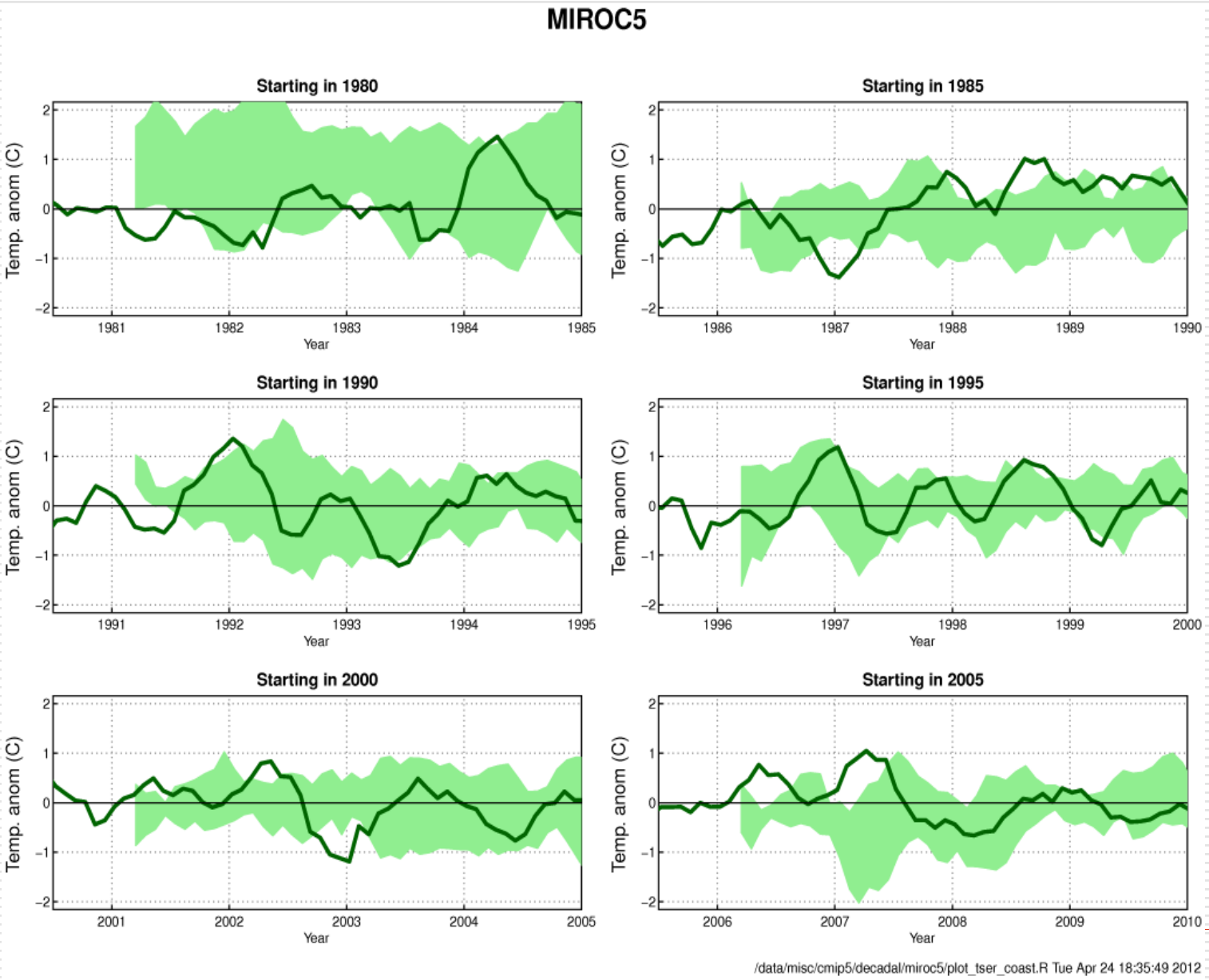
Alfaro et al. JCLIM

San Jose

			Summer CDD	
		Below normal	Normal	Above normal
	Below normal	53%	35%	12%
PDO spring	Normal	35%	36%	29%
	Above normal	12%	29%	59%

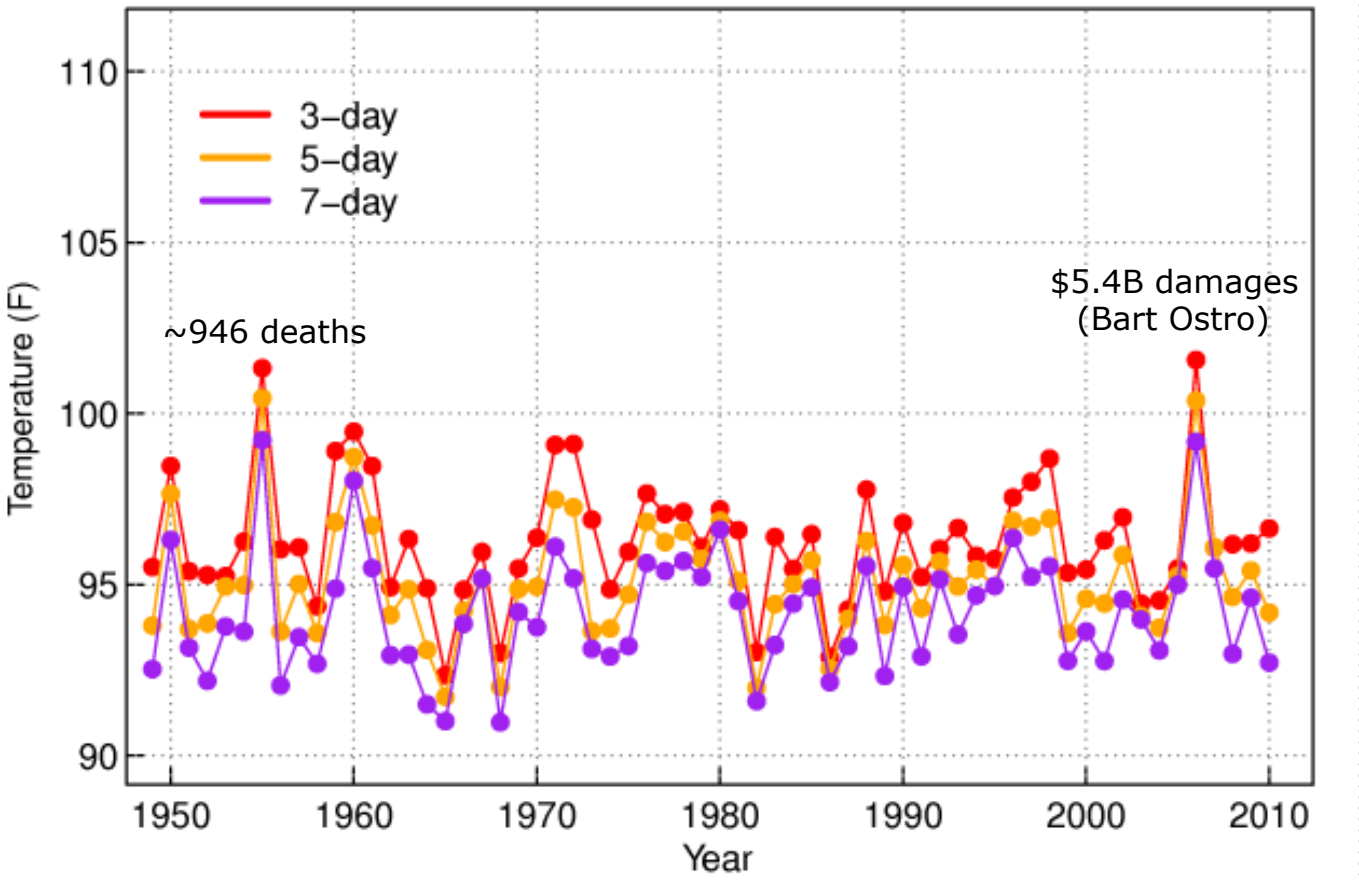
Significance:	0.01	0.05	0.10

Dynamical predictability over a few years?

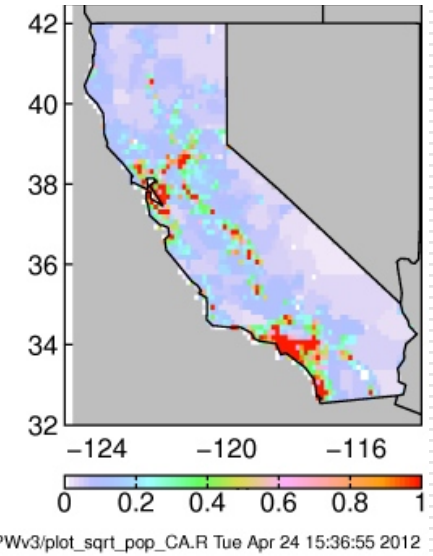


6-member ensembles; envelope shown

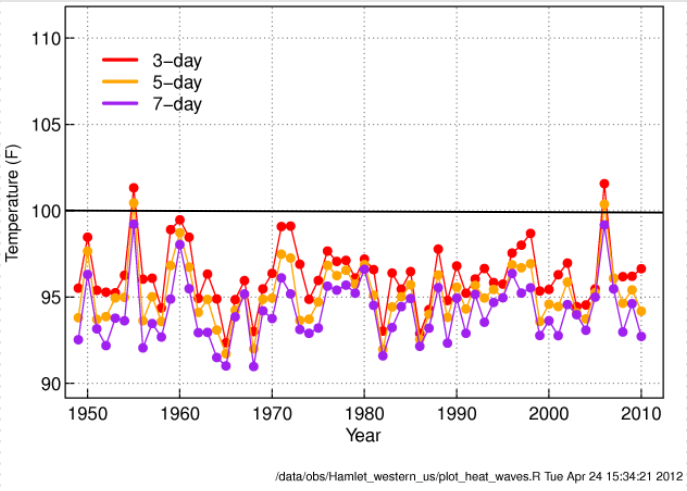
Future of California heat waves

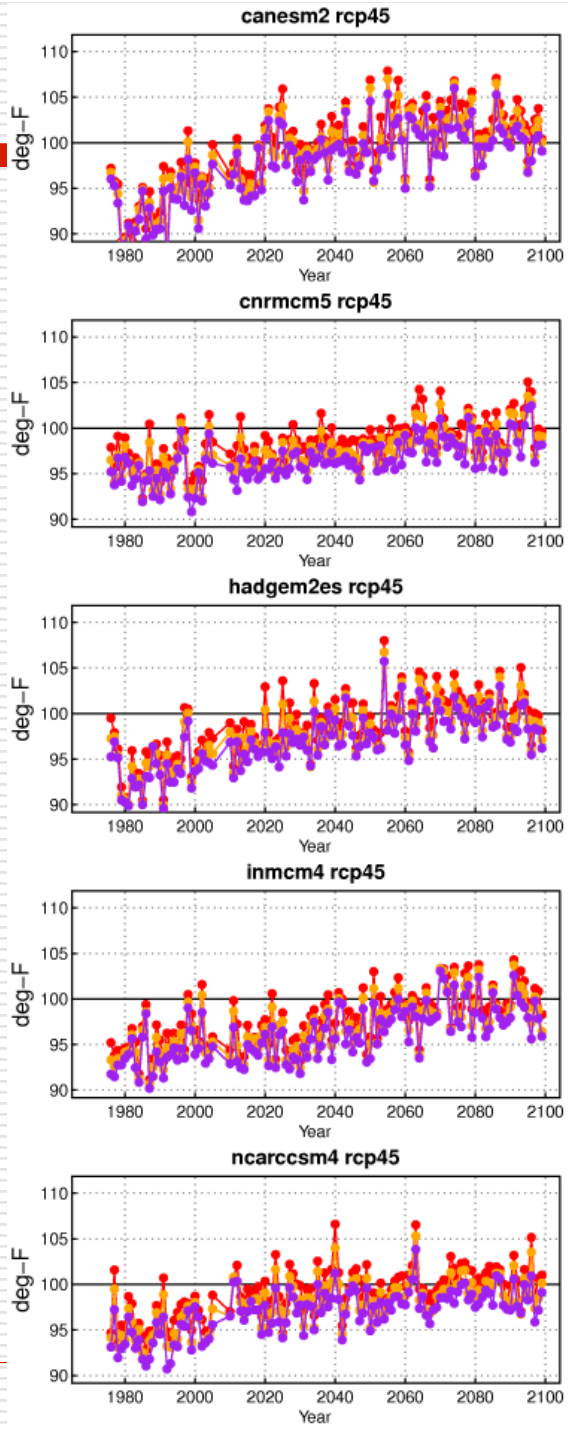


Weighted by population



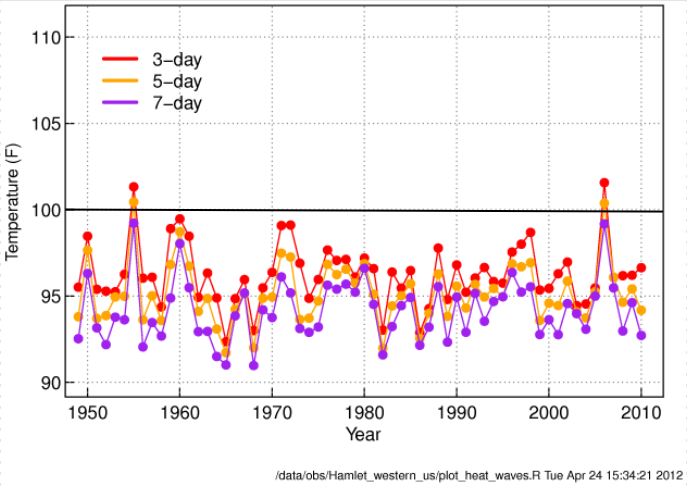
CMIP5 models



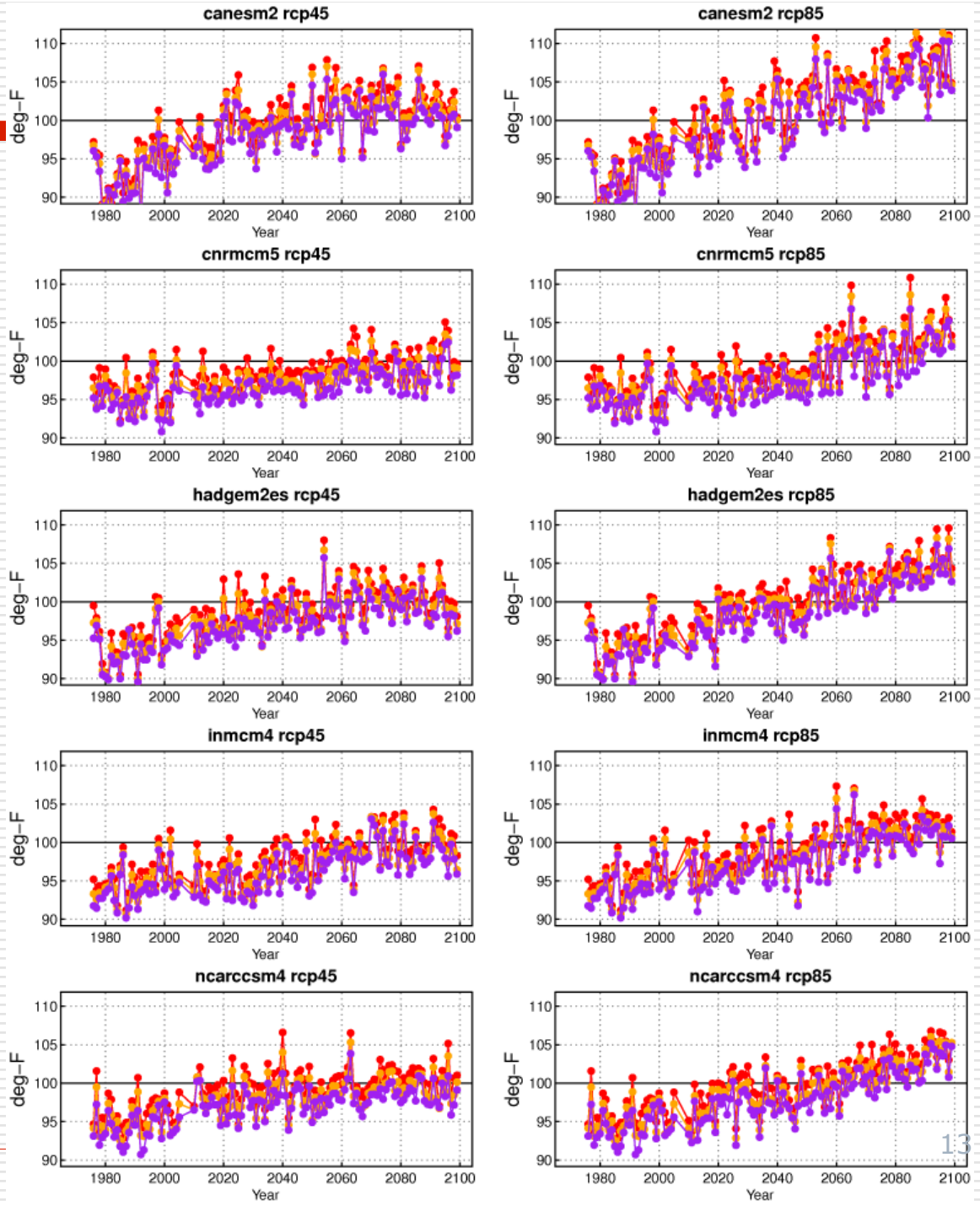


Bias-corrected
BCCA downscaling

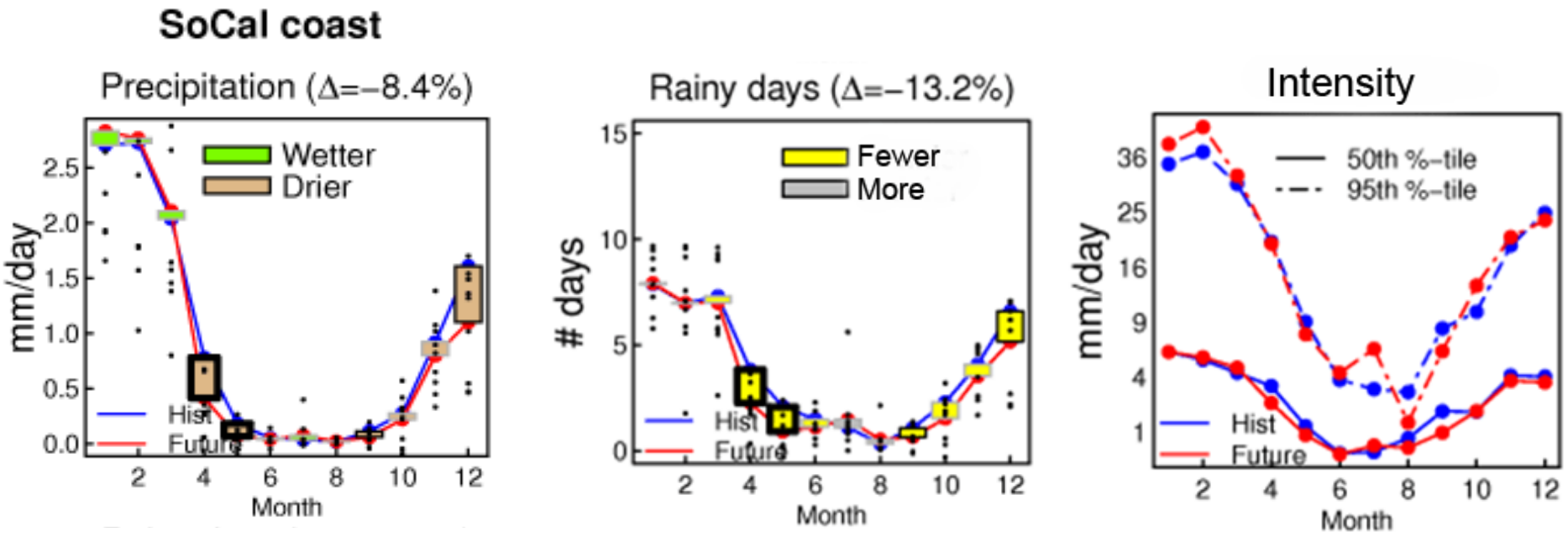
CMIP5 models



Bias-corrected
BCCA downscaling



Change in number of rainy days by 2060s



Pierce et al., CEC Scenarios project

Summary

- Operational El Nino/La Nina forecast (9-12 mos)
- Pacific Decadal Oscillation (PDO) important for energy use
  - Affects winter heating degree days, and Tmax in summer
  - Some ability to predict statistically the summer ahead (3 mos.)
- Dynamical prediction of PDO not encouraging > 1 season
- Damaging heat waves increase by 2020-2040
- Emission scenarios make a difference after 2070
- Changes in precipitation are complex combination of frequency and intensity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